UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

ACADEMY FOR COMPUTER SCIENCE AND SOFTWARE ENGINEERING

MODULE IT00177
COMPUTER GRAPHICS

CAMPUS AUCKLAND PARK CAMPUS (APK)

EXAM
JUNE

DATE: 2016-06-07 **SESSION:** 08:30 - 10:30

ASSESSOR(S): **MR. A. MAGANLAL**

EXTERNAL MODERATOR: **DR. MARDÉ HELBIG**

DURATION: 120 MINUTES **MARKS:** 100

Please read the following instructions carefully:

1. Answer **all** questions.
2. Write clearly and legibly.
3. Use diagrams where necessary to assist in your explanations.
4. Non-programmable calculators are allowed.
5. Round final answers to three decimal places.
6. This paper consists of 2 page(s).

Question 1

Answer only one part. Either **Matrix** or **Quaternion**

(a) **Matrix**

Construct a matrix to rotate 297° (clockwise) around the axis specified by

$$(16,0,0) \rightarrow (23,-8,1)$$

Rotate the point $(-4,9,-9)$ around this axis.

(b) **Quaternion**

Construct a quaternion to rotate 297° (clockwise) about the axis $(7,-8,1)$.
Use the quaternion to rotate $(-20,9,-9)$ around this axis.

Total: 10

Question 2

Write down the Phong lighting equation for a single colour light source and object (black and white model).
Now calculate the viewed intensity of a point on an object given the following attributes:

- The object has an emissive coefficient of 0.175.
- The ambient light intensity is 0.393.
- The object has an ambient coefficient of 0.958.
- The object has a diffuse reflection coefficient of 0.125.
- The object has a specular reflection coefficient of 0.7.
- The shininess (specular highlight) factor is 10.
- The intensity of the incoming light (both specular and diffuse) is 0.717.
- The point we are considering is $(11,3,-8)$.
- The normal at the surface is $(0.942918,-0.332795,-0.0123597)$.
- The light is positioned at $(7,17,2)$.
- The viewer is positioned at $(-1,-8,-3)$.

Total: 15

Question 3

Derive a matrix that can be used to rotate points in a homogeneous representation around an arbitrary axis by an arbitrary angle.

Total: 20

Question 4

Write down the equation for a Bézier curve of degree 3 (cubic).

Total: 10

Question 5

Discuss one of the subdivision surfaces presented in the course.

Total: 10

Question 6

Derive a test for intersection between a triangle and a ray.

Total: 5

Question 7

(a) An eager first year student wishes to write a ray tracer. [05]
What advice would you provide to such a student?

(b) Provide a brief discussion on one of the following: [05]

- Screen-Space Ambient Occlusion
- Deferred Rendering

Total: 10

Question 8

You are required to render an indoor scene of the University of Johannesburg. Describe which advanced lighting techniques (such as radiosity, photon mapping, ambient occlusion etc.) you will select to render the scene. Explain the techniques you have selected and refer to the performance and/or quality of the selected techniques. Your explanation must provide sufficient detail concerning how the algorithms are implemented to justify any comments concerning performance and/or quality.

Total: 20

THE END!